Electric field-controlled directed migration of neural progenitor cells in 2D and 3D environments.

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Public Summary:
The authors described in details the protocols of using electric fields to guide migration of neural stem cells. They present a video demonstration of standard methods based on a calculated field strength to set up 2D and 3D environments. This system allows high-resolution imaging using cover glass-based dishes in tissue or organ culture with 3D tracking of single cell migration in vitro and ex vivo.

Scientific Abstract:
Endogenous electric fields (EFs) occur naturally in vivo and play a critical role during tissue/organ development and regeneration, including that of the central nervous system(1,2). These endogenous EFs are generated by cellular regulation of ionic transport combined with the electrical resistance of cells and tissues. It has been reported that applied EF treatment can promote functional repair of spinal cord injuries in animals and humans(3,4). In particular, EF-directed cell migration has been demonstrated in a wide variety of cell types(5,6), including neural progenitor cells (NPCs)(7,8). Application of direct current (DC) EFs is not a commonly available technique in most laboratories. We have described detailed protocols for the application of DC EFs to cell and tissue cultures previously(5,11). Here we present a video demonstration of standard methods based on a calculated field strength to set up 2D and 3D environments for NPCs, and to investigate cellular responses to EF stimulation in both single cell growth conditions in 2D, and the organotypic spinal cord slice in 3D. The spinal cordslice is an ideal recipient tissue for studying NPC ex vivo behaviours, post-transplantation, because the cytoarchitectonic tissue organization is well preserved within these cultures(9,10). Additionally, this ex vivo model also allows procedures that are not technically feasible to track cells in vivo using time-lapse recording at the single cell level. It is critically essential to evaluate cell behaviours in not only a 2D environment, but also in a 3D organotypic condition which mimicks the in vivo environment. This system will allow high-resolution imaging using cover glass-based dishes in tissue or organ culture with 3D tracking of single cell migration in vitro and ex vivo and can be an intermediate step before moving onto in vivo paradigms.